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ABSTRACT

The research reported here examines the influence of knowledge of two languages on the organization of semantic information in long-term memory. Eight English-French bilingual adults were presented pairs of letter strings and had to decide whether both strings were words. Half of the trials contained English-French word pairs which required a "yes" response. Of these, half were translation pairs and half were semantically unrelated English-French word pairs. Reaction times for the translation pairs were found to be significantly faster than those of the semantically unrelated word pairs. When this result is compared against a similar monolingual lexical decision task, it is found that the magnitude of this semantic facilitation effect is much larger, both in absolute time reduction and in the proportion of variance accounted for by the manipulation. The presence of this semantic facilitation effect indicates that the meanings of words from different languages are organized in a common area of bilingual semantic memory. (Author)

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Semantic Facilitation on a Bilingual Lexical Decision Task

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Semantic Facilitation on a Bilingual Lexical Decision Task

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I'd like to begin my talk with the warning that I'll be presenting a lot of theory and only a little bit of data. The main point of my presentaion is to address the question of how knowledge of two languages can influence the organization of semantic information in human memory and to help lay the foundation for a general model of bilingual memory. Allow me to begin by reviewing some of the research that has been done on the semantic memory of monolinguals.

In the last decade a great deal of memory research has focused on the organization of monolingual semantic memory. Broadly defined, semantic memory is our long-term repository for linguistic and general knowledge. Although many techniques and theories have been developed to examine and model semantic memory this talk will concentrate on the lexical decision task and the Collins and Loftus (1975) model of semantic memory.

The lexical decision task is a word recognition task in which a subject is presented a string of alphabetic characters and must decide whether the string spells a real word (i.e., a word that is known through social convention or can be found in a dictionary). The lexical decision task is a very flexible task in that it lends itself to many different experimental manipulations. In this talk I will be concerned with how variations in the semantic relationship between letter strings that are words affect the recognition times for those words.

Meyer and Schvaneveldt's 1971 research provides the classic example of this paradigm. In their experiment subjects were presented pairs of letter strings simultaneously and had to decide whether both strings were words. If both strings were words they responded by pressing a button indicating a Yes

response, otherwise they pressed another button to indicate a No response. Half of the letter strings were word pairs and half were a mixture of word-nonword pairs. The word pairs were further subdivided into semantically related word pairs like DOCTOR-NURSE and semantically unrelated word pairs like DOCTOR-BUTTER. These examples are provided in the first column of Table 1. Meyer and Schvaneveldt found that the related words were recognized about 85 msec faster than the unrelated word pairs. They termed this reduction in recognition time for related word pairs the semantic facilitation effect.

The explanation for the semantic facilitation effect assumes a particular structure and organization of semantic memory. The usual explanation goes something like this. Deciding that a letter string does correspond to a known word requires a search of long-term memory for a representation of the word. The first representation that is accessed is the sensory representation of the word. That is, the graphemic and phonemic information for the word is accessed. In the Collins and Loftus (1975) model this memory for the sensory representation of words would be called the "dictionary." After the sensory representation has been accessed processing continues to a semantic level. It is at this point that the semantic facilitation effect begins.

Imagine that semantic information for words is represented as a network of nodes. Each node contains abstract conceptual information for a specific word. In other words, the node contains no information about a word's orthography or phonology. Semantically similar concepts are grouped close together and are linked by paths. A node in the semantic network has a path from the dictionary, from its sensory representation, and paths conecting nearby concepts.

After the sensory representation has been accessed a word's node in the semantic network is accessed. Accessing this node activates the concept. This activation is not restricted to the accessed concept though. Rather, there is

Table 1. Examples of word pairs from a monolingual lexical decision task and a bilingual lexical decision task using translation pairs.

	Lexical Decision Task	
Word Pair Type	Monolingual	Bilingual
Related	DOCTOR NURSE	DOCTOR MEDECIN
Unrelated	DOCTOR BUTTER	DOCTOR BEURRE

a spread of activation from the accessed concept to nearby concepts. This spreading activation partially activates the nearby concepts and makes them easier to activate. This spreading activation apparently decays rapidly and does not go beyond immediate neighbors. The result is that if a related concept is immediately accessed it will be easier and faster to activate it.

The foregoing explanation for the semantic facilitation effect makes the following assumptions about semantic memory:

1. Semantic information is represented abstractly in the form of a network of concepts. Specific concepts are represented as nodes in the network and concepts are connected to each other via links in the network.

2. Semantically similar concepts are grouped together. The length of the path between concepts varies as a function of the similarity of the concepts. Highly similar concepts will have short connections while dissimilar concepts will have long path connections, if they are connected at all.

3. Accessing a node in the network results in a burst of activation at the accessed node which then spreads to neighboring nodes. This spreading activation reduces the amount of activation needed for these concepts and results in faster access.

The foregoing assumptions about semantic memory are loosely based upon the work of Meyer and Schvaneveldt (1976) and Collins and Loftus (1975). Given this background on monolingual semantic memory let us now make some speculations on the organization of bilingual semantic memory.

If one observes the language behavior of bilinguals one will immediately notice that bilinguals maintain good control over the two languages that they know. By control I mean that they maintain separation of the languages that they know. Infrequently, there will be mixtures of the two languages but this will be done usually in the company of other bilinguals who will be able to understand the mixture. The question that arises is how is this separation of languages maintained in the cogntive system? The research that has been done to date on bilingual cognitive processing has generated two opposing theoretical

positions. The first position contends that language separation stems from separate representations in memory. That is, there are two separate memory stores for the languages. This position suggests that there is little if any direct interaction between the two memory stores. Any interaction that does occur would be mediated by some translation process. This position has been refered to as the dual-store or independent languages model of bilingual memory.

The second position contends that the two languages operate within the same system and that the languages are only functionally distinct. In this model the two language systems can have direct interactions in memory and occupy a common storage area. This position has been refered to as the single-store or language interdependence model of bilingual memory. My recounting of these two positions is necessarily brief and superficial. I refer the interested listener to the references by McCormack (1974, 1977) for a fuller discussion of these issues.

Those of you who have been listening closely will have noticed that I have avoided making a distinction between the sensory and semantic components of language in my presentation of the dual and single-store models of bilingual memory. This was intentional. The theorists that have worked in this area have often lumped the two components together and have refered to this joint representation as a single entity. The reason why this may have been an unfortunate thing to do is that the possibility exists that there could be separate stores for sensory language information and a single store for semantic language information. The reverse condition could also exist. I would like to suggest that we attempt to look at the sensory and semantic components separately and attempt to learn whether there is a single or dual store for these components.

This suggested separation of sensory and semantic components is tantamount to asking specific questions that are addressed primarily to, say, the dictionary or the semantic network in the Collins and Loftus model. Neither component can be tested separately from the other but on certain tasks the effect of one component may override any effect of the other component. The experiment I will be reporting here addresses itself to the question of whether there is a single- or dual-store in bilingual semantic memory. Although there are obvious sensory components involved in processing for the lexical decision task it is felt that their relative contribution will be minor in contrast to the manipulation of the semantic components.

The experiment used here is a bilingual version of the Yes-No lexical decision task developed by Meyer and Schvaneveldt (1971). The relevant word pair conditions are shown under the bilingual column heading in Table 1. In this experiment two types of word pairs were used: English-French translation pairs and semantically unrelated English-French word pairs. It was hypothesized that if there is a dual store in bilingual semantic memory little if any semantic facilitation should be observed. This follows from the assumption that the two stores are separate entities and any interaction between the two is mediated by a translation process. If there is a single semantic store then a significant semantic facilitation effect should be observed. This follows from the assumption that the two languages operate in the same system and have direct interactions.

Now for details of the experiment. Eight English-French bilinguals from the State University of New York at Stony Brook participated. The subjects were undergraduates, faculty, and staff from different departments in the university. Background data indicated that all subjects used English predominantly in both social and cognitive usage. Self-rating of ability in French indicated that the subjects had a moderate to good command of the language.

The language materials were words and nonwords derived from English and French. English words were taken from Paivio, Yuille, and Madigan's (1969) list and were selected for their high concreteness, high frequency of occurance properties. French translation of the English words were gotten from a French-English dictionary (Mansion, 1973) and apropriateness of the translation pairs was checked by a bilingual judge. Although translation pairs could not be matched for concreteness values they could be matched for frequency. Eaton (1961) provides rank order frequency information for English words and their French translations. Using this information a Spearman's rho between rank order frequency of the English words and their French translations gave a value of rho= .73 (z=5.36). This means that words within a translation pair were roughly matched for rank order frequency.

Nonwords were derived from real English and French words by altering a letter ir the word until its spelling did not constitute a legitimate word in either language.

Trials were presented tachitoscopically and had the following structure. The subject self-initiated a trial and the first presentation consisted of a white field with an "X" located in the center. This fixation field remained on for 2000 msec. This was immediately followed by the presentation of a pair of letter strings. One string was located above the other in the center of a white field. This letter string presentation lasted 2000 msec regardless of the subject's response. Subjects had to press a switch in one direction if both letter strings were words (a Yes response) and in the other direction if at least one of the strings was nonword (a No response). Reaction time was measured from the onset of the letter string field to the time of the subject's response. Subjects were presented 144 trials in three blocks of 48 trials each. The first block was practice and its data was not recorded. The subject was instructed to respond as quickly as possible but not at the expense of accuracy.

Table 2 presents the reaction times for the word conditions in this experiment as well as those from Meyer and Schvaneveldt (1971). For the present let's concentrate on the bilingual data. It is obvious that the translation pairs were recognized faster than the semantically unrelated English-French pairs. The semantic facilitation effect, that is, the difference between the related and the unrelated conditions, is 191 msec. A repeated measures ANOVA confirmed the significance of this difference [$F(1,7)= 18.96$; $p < .003$]. The magnitude of effect is given by eta^2 where 73% of the variance is accounted for.

It is of some interest to compare the present results with those of Meyer and Schvaneveldt. A comparison is allowable because the two experiments follow the same design save for the language manipulation. Although subjects in the present experiment were slower than Meyer and Schvaneveldt's all of them showed a reliable and robust semantic facilitation effect. It is not clear why these difference between the two experiments exist. Perhaps the language manipulation is the basis but more work needs to be done on this point.

The interpretation of the results is straightforward. From the Collins and Loftus model we can assert that there is a single semantic network for the two languages a bilingual knows. Accessing a concept in one language results in a spread of activation in the semantic network that facilitates the activation of concepts in both languages. It seems that semantic information is language independent and its orgnaization in long-term memory appears to based solely on the similarity of semantic features of the concepts. Bilingual semantic memory is best described as a single store in which language membership plays little if any role in organizing semantic information.

The presence of semantic facilitation on the bilingual lexical decision task is not very surprising. This result dovetails nicely with other research supporting a single store model albeit with different tasks (Barnett, 1977;

Table 2. Mean Reaction Time (RT) in milleseconds for correct responses on a Yes-No lexical decision task with simultaneous word pair presentations. Monolingual data are from Meyer and Schvaneveldt (1971).

	Lexical Decision Task	
Word Pair Type	Monolingual	Bilingual
Related	855msec	1139msec
Unrelated	940	1330
Mean RT word pair conditions	897	1234
Semantic Facilitation Effect	85	191
eta^2	.65	.73

Hines, 1978; McCormack, 1977). The problem that must be dealt with is how to reconcile these findings with research that is used as evidence for a dual-store model of bilingual memory (e.g., Kolers and Gonzalez, 1980). I believe the reconciliation lies in the distinction between the sensory and the semantic properties of a language and to the extent that these components contribute to an effect observed on a memory task. As Hines in his 1978 Doctoral thesis has shown a memory task can provide evidence for either a single or a dual store model depending upon the dimension being manipulated. Manipulation of semantic variables across languages appears to support a single store representation while manipulation of orthographic and phonological variables seems to provide evidence of dual memory stores.

The model that suggests itself is one in which there is a realization of the separate sensory and semantic dimensions of a language and that different variables will affect these dimensions. The contribution of either dimension depends upon the memory task being used. If semantic information is organized in long-term memory on the basis of similarity of semantic features is it not possible that the organization of sensory information is based on the similarity of sensory features? Words within a language more likely to similar to each other than to words from other languages (in terms of their orthographic and phonological features) and, as a result, it should not be surprising to find that the sensory representations of words from different languages are organized on a language category basis (i.e. dual stores). Admittedly, this is mostly speculation and more work needs to be done before an adequate model of bilingual memory can be developed.

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